DESIGN EXAMPLES

1. DESIGN EXAMPLE 1 - U-FRAME LOCK

A. Design Conditions

In this design example, two loading conditions are illustrated:

CASE I: Normal Operating Condition

a. Upper pool elevation - 95.0 ft
b. Lower pool elevation - 64.0 ft
c. Lower pool in lock chamber

CASE II: Extreme Maintenance Condition

a. Upper pool elevation - 95.0 ft
b. Lower pool elevation - 81.0 ft
c. Lock chamber dewatered

B. Structural Dimensions and Loading Conditions

The structural dimensions and loading diagrams are shown in Figure 2-1. The loads are tabulated in Table 2-1.

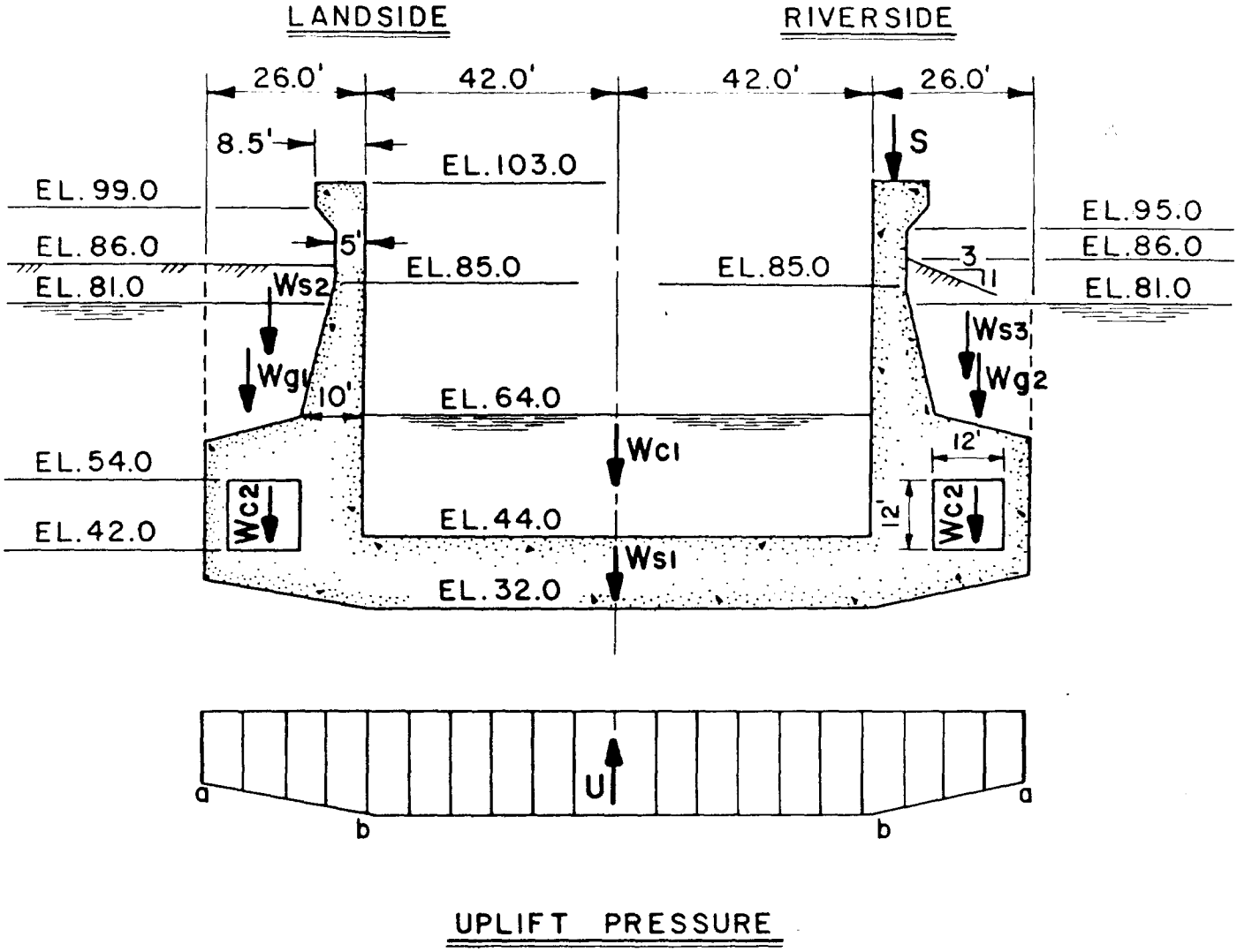

Figure 2-1 Structural Dimensions and Loading Diagrams

Table 2-1 Summary of Loads

Loads	Loading Conditions* CASE I	CASE II
Weight of the structure, W_{s1}	407.7	407.7
Weight of soil above the lock on landside, W_{s2} #	36.2	36.2
Weight of soil above the lock on riverside, W_{s3} #	24.8	24.8
$W_s = W_{s1} + W_{s2} + W_{s3}$	468.7	468.7
Weight of water in lock chamber, W_{c1}	105.0	0
Weight of water in culvert, W_{c2}	18.0	0
$W_c = W_{c1} + W_{c2}$	123.0	0
Weight of water above the lock on landside, W_{g1}	21.1	21.1
Weight of water above the lock on riverside, W_{g2}	17.6	17.6
$W_g = W_{g1} + W_{g2}$	38.7	38.7
Uplift pressure at point a (See Fig. 2-1)	2.44**	2.75**
Uplift pressure at point b (See Fig. 2-1)	3.09**	3.40**
Total uplift, U	365.9	454.3
Surcharge load, S	0	0

* All loads are in kips/ft except as noted
** Uplift pressures are in kips/sq ft
\# Saturated weight (130 lbs/cu ft) is used for soil above EL. 81.0 and submerged weight (67.5 lbs/cu ft) is used for soil below EL. 81.0

C. Flotation Safety Factors

The flotation safety factors can be calculated by substituting the appropriate loads from Table 2-1 into Equation (1) in the basic letter:

CASE I : Normal Operating Condition

$$SF_f = \frac{W_s + W_c + S}{U - W_g} \qquad (1)$$

$$= \frac{468.7 + 123.0 + 0}{365.9 - 38.7}$$

$$= 1.81 > 1.5 \quad \text{O.K.}$$

CASE II: Extreme Maintenance Condition

$$SF_f = \frac{W_s + W_c + S}{U - W_g} \qquad (1)$$

$$= \frac{468.7 + 0 + 0}{454.3 - 38.7}$$

$$= 1.13 > 1.1 \quad \text{O. K.}$$

2. DESIGN EXAMPLE 2 - STILLING BASIN

A. Design Condition

The water profile used for the unusual operating condition with one tainter gate half open is shown in Figure 2-2. The upper pool elevation is at EL. 95.0 and the tailwater is at EL. 64.0. The drain effectiveness for uplift calculation is assumed to be 50%.

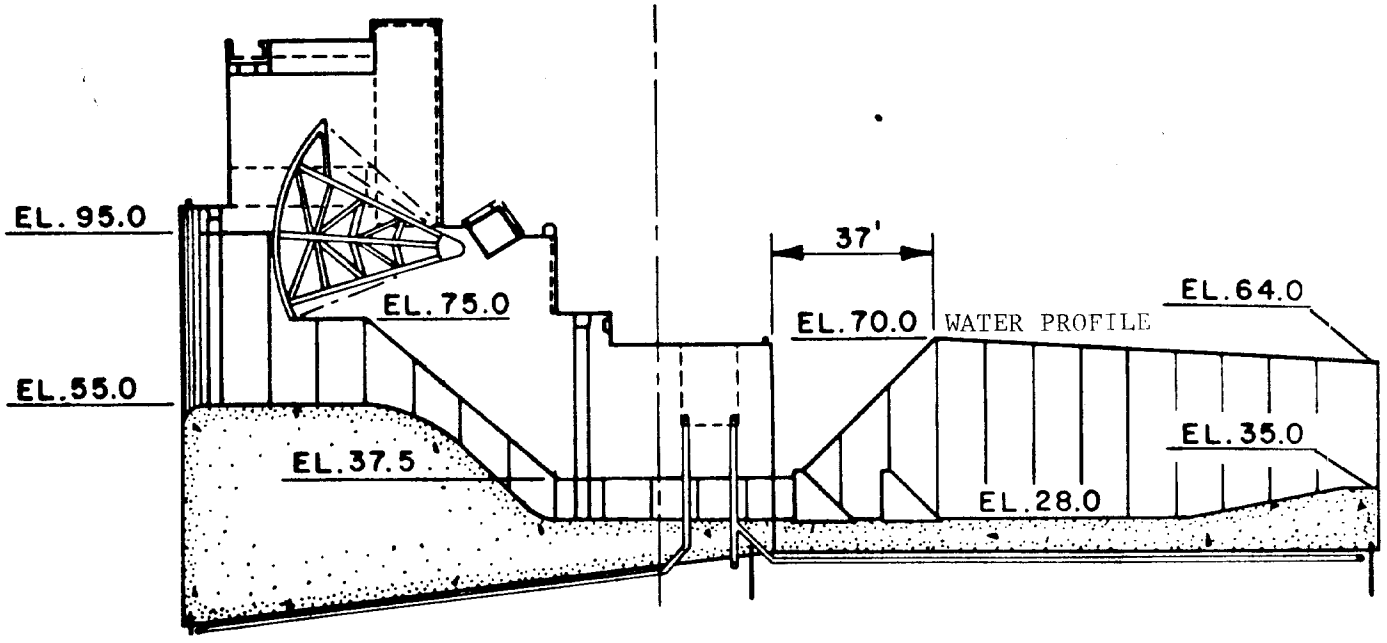

Figure 2-2 Stilling Basin Water Profile

B. Structural Dimensions and Loading Condition

The structural dimensions for the stilling basin are given in Figure 2-3.

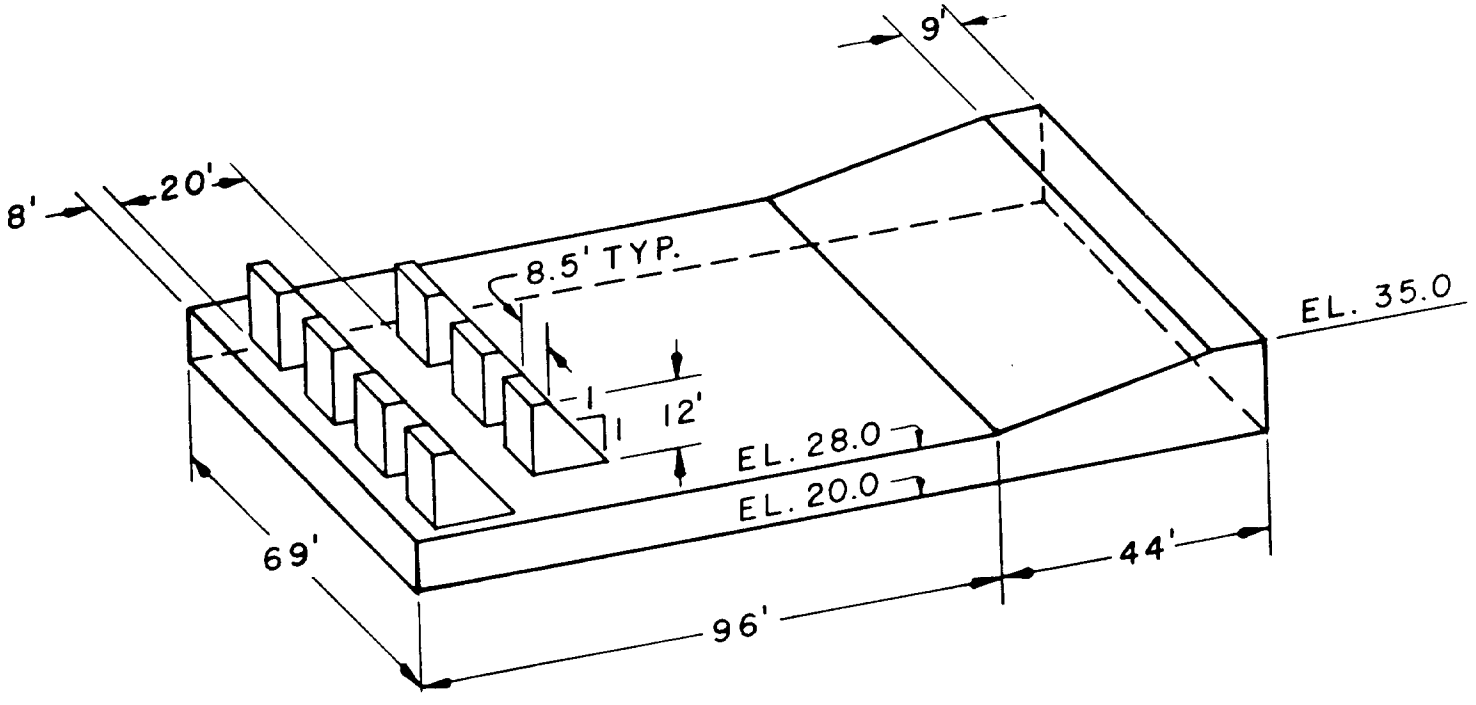

Figure 2-3 Structural Dimensions, Stilling Basin

The final loading condition is shown in Figure 2-4. It should be noted that, in this design example, the results of the stability analysis indicate that a portion of the stilling basin slab is not in compression. Full uplift force is applied for the portion of the slab that is not in compression and the final uplift distribution as shown in Fig. 2-4 is obtained through an iteration process. From the information given in Figs. 2-2, 2-3, and 2-4, it can be shown that:

W_s = Weight of the concrete stilling basin = 212.6 kips/ft
W_c = Weight of the water contained in the basin up to EL.35.0
= 44.5 kips/ft
W_g = Weight of the water above EL. 35.0 = 244.3 kips/ft
U = Final uplift force = 441.2 kips/ft

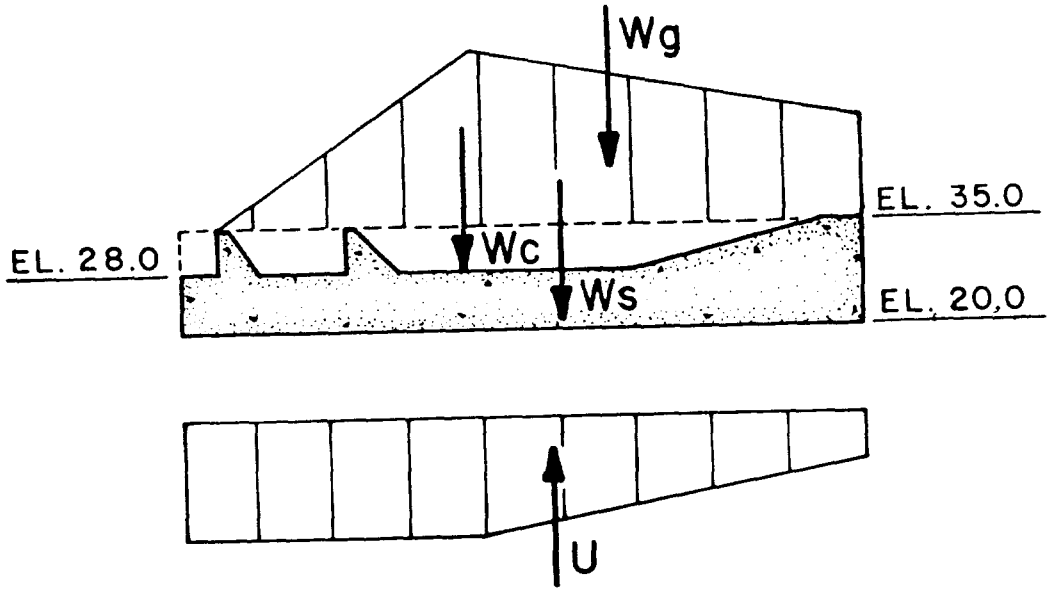

Figure 2-4 Loading Conditions, Stilling Basin

C. Flotation Safety Factor

The flotation safety factor can be calculated by substituting the loads into Equation (1) in the basic letter:

$$SF_f = \frac{W_s + W_c + S}{U - W_g} \qquad (1)$$

$$= \frac{212.6 + 44.5 + 0}{441.2 - 244.3}$$

$$= 1.31 > 1.3 \quad \text{O. K.}$$

3. DESIGN EXAMPLE 3 - PUMPING STATION

A. Design Condition

The loading conditions for an unusual operation condition with water in sump at EL. 249.0 when pumps are shutoff are shown in Figure 2-5. The saturation line is at EL. 263.4 and moist fill is used above saturation line.

B. Structural Dimensions and Loading Conditions

The structural dimensions and loading diagrams are shown in Figure 2-5. It can be shown that

W_s = Weight of the structures
= B + R + S_B + P + S.G. + V.P.
where B, weight of the superstructure = 333.5 k
R, weight of the trash rack = 30.1 k
S_B, weight of the substructure = 2694.1 k
P, weight of the pumps, motors, and equipment = 152.0 k
S.G., weight of the switch gear = 17.2 k
V.P., weight of the vacuum pump = 1.0 k

W_s = 333.5 + 30.1 + 2694.1 + 152.0 + 17.2 + 1.0
= 3227.9 k
U = Uplift = 3080.6 k
W_c = Weight of the water contained within the structure = 0 k
S = Surcharge loads = 0 k

Because of the open trash rack, the water in the sump is controlled by gravity flow, and therefore; weight of the water in the sump should be treated as W_g.

W_g = 45 x 37.71x 6 x0.0625 = 636.36 k

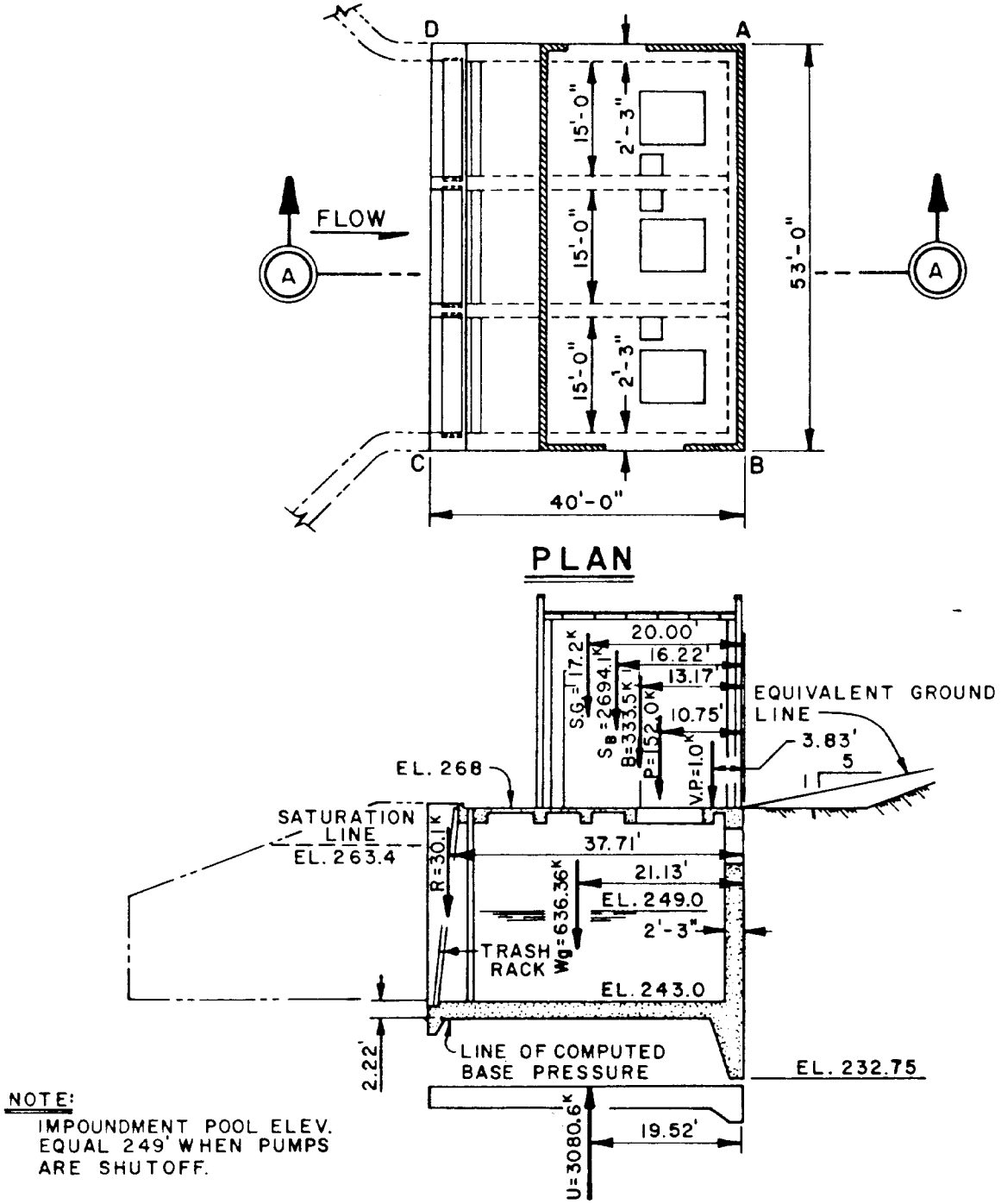

Figure 2-5 Pumping Station Dimensions and Loading Diagrams

C. **Flotation Safety Factor**

$$SF_f = \frac{W_s + W_c + S}{U - W_g} \qquad (1)$$

$$= \frac{3227.9 + 0 + 0}{3080.6 - 636.36}$$

$$= 1.32 > 1.3 \quad \text{O.K.}$$